

The Upper Basin, Lower Basin, and Mexico: Coexisting on the Post-2026 Colorado River

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Abstract: Misuse of science in the apportionment of the Colorado River's water in the 20th century led to an overallocation problem that must be addressed. Rules based on overestimation of the available water supply have allowed overuse in the Lower Colorado River Basin and left uncertainty about the obligation of various basin water users to contribute water toward meeting U.S. treaty obligations to Mexico. With a number of key water management agreements expiring in 2026, basin managers have an opportunity to correct the overallocation problems with negotiated agreements that reflect the reality of the river's hydrology and reduce risks associated with winner-take-all litigation.

Introduction

With the Upper and Lower Basin Colorado River Drought Contingency Plans (DCPs) now complete¹, the Colorado River basin's water management agencies, states, NGOs, tribes, and Interior Department officials will be turning their attention to the next major milestone; how the Colorado River will be managed beginning in water year 2027. The river is currently

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** This is the second in a series of working papers exploring the policy implications of the book *Science be Dammed: How Ignoring Inconvenient Science Drained the Colorado River*, Tucson, University of Arizona Press, forthcoming fall 2019

¹ "Colorado River Basin Drought Contingency Plans", U.S. Bureau of Reclamation, updated May 20, 2019, <https://www.usbr.gov/dcp/>

operated pursuant to the “Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operation of Lake Mead and Lake Powell” (2007 Interim Guidelines)². The 2007 Interim Guidelines were developed in 2005 and 2006 and signed by Interior Secretary Dirk Kempthorne in 2007. They were designed to expire at the end of calendar year 2025, and cover river operations through the end of water year 2026 (September 30, 2026). The 2007 Interim Guidelines contemplate that negotiations for the development of a follow-on agreement will begin no later than 2020.

During the development of the 2007 Interim Guidelines, the assumption made by the States of the Lower Division was that Mexico would ultimately share shortages with entities in the United States. This assumption was implemented through Minute 319 and its successor, Minute 323, to the 1944 water treaty with Mexico.³ Additionally, under Minute 323, Mexico has voluntarily agreed to take additional shortages that will work in tandem with the Lower Basin DCP.

Like the 2007 Interim Guidelines, Minute 323 will expire at the end of calendar year 2026. Thus, as U.S. stakeholders move forward with their negotiations to shape the post-2026 river, issues involving Mexico’s water use under the 1944 treaty as well as those related to the use of water in each basin will be on the table.

Post 2026 Colorado River Issues: Climate Change and Hydrology

² “Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead”, U.S. Bureau of Reclamation, updated June 5, 2015, <https://www.usbr.gov/lc/region/programs/strategies.html>

³ “Minutes between the United States and Mexican Sections of the IBWC”, International Boundary and Water Commission, https://www.ibwc.gov/treaties_minutes/minutes.html

The signature factor influencing the post 2026 Colorado River will be the hydrology. Simply put – how much water will be available in the Colorado River for future use and how will climate change impact the long-term water availability? The basic hydrologic assumptions that will be used to develop and evaluate the post-2026 river management alternatives will be critical. The impact of climate change on the yield of the Colorado River is a complicated subject. The consensus appears to be that while certain northern tributaries like the Yampa River may see increased precipitation and stream flow, stream flows on the southern tributaries will probably decline. The net impact on the natural flow at Lee Ferry is expected to be a decline.⁴ Most recently several studies have shown that increasing temperatures in the basin are already having a significant detrimental impact on natural flows at Lee Ferry.⁵

There can be no dispute that hydrologic conditions since 2000 throughout the Colorado River Basin have been dry. The estimated average natural flow at Lee Ferry for the nineteen year period of 2000-2018 is only 12.4 million acre-feet per year, about 16% below the 1906-2017 average of 14.8 million acre-feet per year.⁶ During this period, total storage in the two large system reservoirs, Lake Mead and Lake Powell, has dropped from nearly full in early 2000 to about 40% full at the end of calendar year 2018. This precipitous decline in system storage was the primary cause for the development of the basin DCPs and Minutes 319 and 323.

⁴ The 2012 Colorado River Basin Supply and Demand Study CMIP3-based climate change hydrology showed a 9% decline over 50 years. The results of the more recent CMIP5-based climate change modeling are not as clear.

⁵ Udall, B., & Overpeck, J. (2017). The twenty-first century Colorado River hot drought and implications for the future. *Water Resources Research*, 53(3), 2404-2418; Woodhouse, Connie A., et al. "Increasing influence of air temperature on upper Colorado River streamflow." *Geophysical Research Letters* 43.5 (2016): 2174-2181.

⁶ The 12.4 million acre-feet per year is based on the Bureau of Reclamation's Natural Flow Data Base, August 2018 version, for water years 2000-2017 ("Colorado River Basin Natural Flow and Salt Data", U.S. Bureau of Reclamation, updated April 1, 2019, <https://www.usbr.gov/lc/region/g4000/NaturalFlow/current.html>) and preliminary estimates by Dr. James Prairie (USBR) for water year 2018. For this paper the authors are using the natural or actual flows of the river at Lee Ferry, the official compact point. To obtain the flow at Lee Ferry, one adds the flow of the Colorado River at Lees Ferry to the flow of the Paria River at its mouth. Lees Ferry (or Lee's) is located one mile upstream of Lee Ferry.

The natural flow at Lee Ferry is not the same as the natural flow of the entire Colorado River system. The Bureau of Reclamation’s Natural Flow Data Base includes estimates natural inflows to Lake Mead and down the river to Imperial Dam, but the data base does not include the Gila River system, by far the Lower Basin’s largest tributary. Based on the limited information available, the authors estimate that the natural flow of the Colorado River at the international boundary for the 1906-2018 period is about 16 million acre-feet per year and for the 2000-2018 period about 13.2 million acre-feet per year.⁷ The following table shows the estimated natural flows at Lee Ferry for different periods and from a number of different sources:

Natural Flow at Lee Ferry

SOURCE	PERIOD	FLOW (million af/year)
USBR NFDB (2019)	1906-2017	14.8
USBR NFDB (2019)	1931-2017	14.0
USBR NFDB (2018) “stress test”	1988-2016	13.2
USBR NFDB (2019) +18 (est)	2000-2018	12.4
TreeFlow.org (2018) ⁸	1416-2015	14.3
HD 419 (1947) ⁹	1897-1943	16.3
A.P. Davis (1923) ¹⁰	1902-1920	18.1
Sibert Board (1928)	1870s-1920s	14.2

⁷ The estimate is based on the hydrologic appendix to House Document 419 (USBR. *The Colorado River: Natural Menace Becomes a National Resource: Interim Report on the Status of the Investigations Authorized to Be Made by the Boulder Canyon Project Act and the Boulder Canyon Project Adjustment Act*. Washington, D.C.: Government Printing Office, 1947, hereafter “HD 419”) that showed the natural flow at Lee Ferry is 99% of the natural flow at Laguna Dam (just upstream of the confluence of the Gila and Colorado Rivers). What this means is that natural inflow below Lee Ferry and stream losses between Lee Ferry and Yuma are approximately the same. Today’s NFDB shows an increase in natural flow between Hoover Dam and Imperial Dam. According to Dr. Prairie river losses in that reach are now shown as a demand on the system. The 16 million acre-feet per year is derived as follows: $14.8 / .99 + 1$ million acre-feet per year for the Gila River. The 13.2 million acre-feet per year is $12.4 / .99 + 700,000$ for the estimated natural flow of the Gila over the 2000-2018 period.

⁸ The most recent tree-ring based reconstruction on TreeFlow.org for the Colorado River at Lees Ferry is by Meko and Woodhouse and is referred to as the “Most Skillful Model” <https://www.treeflow.info/content/upper-colorado>

⁹ Appendix I, HD 419

¹⁰ Arthur Powell Davis was the director of the Reclamation Service in 1922 during the negotiations of the Colorado river Compact and present during all the negotiating meetings. He became the Commission’s principle advisor on Colorado River hydrology. For a derivation of his estimated natural flow (“virgin” was the common term in 1922) of the Colorado River at Lee Ferry see R. L. Wilbur and N. Ely, *The Hoover Dam Documents*, page A48.

Climate change and the Mexican Treaty

The specter of declining natural flows in the Colorado River Basin caused by anthropogenic climate change raises two fundamental and, as of yet, unresolved issues related to deliveries to Mexico under the 1944 treaty. The first is internal to the United States and involves the Colorado River Compact; what is the obligation of the Upper Basin under Article III(c) of the 1922 compact? Article III(c) was included in the compact because the negotiators understood that a future treaty with Mexico was likely, therefore it needed to define the obligations of each basin in that likelihood. Article III(c) states:

If as a matter of international comity, the United States of America shall hereafter recognize in the United States of Mexico any right to the use of any waters of the Colorado River system, such waters shall be supplied first from the waters which are surplus over and above the aggregate of the quantities specified in paragraphs (a) and (b); and if such surplus shall prove insufficient for this purpose, then, the burden of such deficiency shall be equally borne by the Upper Basin and the Lower Basin, and whenever necessary, the States of the Upper Division shall deliver at Lee Ferry water to supply one half the deficiency so recognized in addition to that provided in paragraph (d).

Since the day the commissioners signed the compact in Santa Fe on November 24th, 1922 the basins have probably never agreed on the interpretation of Article III(c), but it has never been addressed by the Supreme Court. There are several different interpretations of Article III(c). The Upper Basin's obligation at Lee Ferry to Mexico could vary from as little as nothing in most years to over 800,000 acre-feet per year, every year, if the States of the Upper Division have to cover transit losses on the delivery of their treaty water from Lee Ferry to the border.

Since the early 1970s, the river has been operated as if the Upper Basin's obligation to Mexico at Lee Ferry is 750,000 acre-feet per year. With the promulgation of the first long range

operating criteria (LROC) pursuant to section 602 of the Colorado River Basin Project Act¹¹, the Secretary of the Interior set a “Minimum Objective Release” from Glen Canyon Dam of 8.23 million acre-feet per year. The 8.23 million acre-feet happens to be 7.5 million; the average annual obligation of the States of the Upper Division under Article III(d)¹² plus 750,000 acre-feet (1/2 of the normal annual delivery of 1.5 million acre-feet per year to Mexico under the treaty) less 20,000 acre-feet per year, the average annual flow of the Paria River which is an Upper Basin stream that enters the Colorado River below Glen Canyon Dam.

The States of the Upper Division objected to the 8.23 million acre-feet minimum objective release decision. However, they could not convince the secretary of the Interior to change it. To make the decision more acceptable to the Upper Basin, the secretary emphasized that the release was an objective, not a requirement, and the 1970 LROC decision included disclaimer language that the LROC was not an interpretation of the 1922 compact. The 2007 Interim Guidelines put in place a tier system that allows the minimum annual release to vary from 7 to 9.5 million acre-feet per year (7.48 to 9 million acre-feet in the second and third tiers).¹³ However, the 8.23 million acre-feet was, in theory, the fulcrum. The modeling used to develop the guidelines showed that the frequency of releases greater than 8.23 million acre-feet per year would be approximately offset by releases less than 8.23 million, preserving the 8.23

¹¹ “Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs”, U.S. Department of the Interior, <https://www.usbr.gov/lc/region/pao/pdfiles/opcritcr.pdf>

¹² Article III(d) require the States of the Upper Division to not deplete the flow of the Colorado River at Lee Ferry below 75 million acre-feet every ten years, 75 million divided by 10 is 7.5 million.

¹³ The four tiers are the Lower Elevation Balancing tier (tier 1), Mid Elevation Balancing Tier (tier 2), Upper Elevation Balancing tier (tier 3), and the Equalization tier (tier 4). Since 2007, Lake Powell has primarily been in the Upper Elevation Balancing tier (storage >3575’ but less than the equalization level) and releases have been either 8.23 or 9 million acre-feet per year. There have been two years with equalization releases, 2008 and 2011, and one year, 2014, when the reservoir was in the mid-level balancing tier and releases were dropped to 7.48 million acre-feet.

over the 20 year term of the guidelines (except when Lake Powell is in the equalization tier and delivering to the Lower Basin water in excess of the Upper Basin's needs).¹⁴

For the negotiations of the post-2026 river, the States of the Upper Division face a threshold question. Will they again accept post-2016 river operating guidelines based on an assumption that the Upper Basin's obligation to Mexico is 750,000 acre-feet per year or will they force a resolution of this long-standing dispute?

Unlike in 1970 or 2007 when the States of the Upper Division chose to move forward without a resolution, there are now major reasons why these states may have to seek a resolution. With the reality that climate change is reducing the long-term natural flow of the river at Lee Ferry, their fixed obligation to Mexico at Lee Ferry together with their fixed obligation under III(d) to not deplete the flow of the Colorado River below 75 million acre-feet per year every ten years will slowly reduce the water available for consumptive use in the Upper Basin. A second problem is that under the recently approved Upper Basin DCP, the States of the Upper Division have committed to studying the implementation of demand management. If the Upper Basin is making water deliveries at Lee Ferry for Mexico beyond the minimum required by Article III(c), then the amount of water that a future demand management program will have to supply to maintain critical storage levels in Lake Powell will be higher and thus, the costs to operate the program will be higher. Simply put, one of the reasons the States of the Upper Division have avoided pushing for a resolution of their treaty obligation to Mexico was that they were not sure

¹⁴ The fact that under the 2007 Interim Guidelines there have been more years with an annual release of 9 million acre-feet has bothered some in the Upper Basin. If the annual release from Glen Canyon Dam in water year 2020 is 9 million acre-feet as projected, there will have been six straight years with releases of 9 million acre-feet (2015-2020). The authors believe this is, in part, due to the modeling of the 2007 Interim Guidelines options, where the States of the Upper Division overstated their demand schedule and actual consumptive uses have been about 400,000 to 500,000 per year acre-feet less than what was modeled. Thus, for the same natural inflow hydrology, storage levels in Lake Powell have been higher than what was modeled and the reservoir has been in the Upper Elevation Balancing tier more often what was modeled.

they could make the case that any water user or state was impacted or injured by Interior's decisions to operate Glen Canyon Dam as if the Upper Basin's obligation was 750,000 acre-feet per year. Today that is no longer the case.

The second major issue involves the extraordinary drought provision of the 1944 treaty. Article 10 of the treaty, which provides for the annual delivery of 1,500,000 acre-feet per to Mexico (1,850,234,000 cubic meters), also includes a drought provision. It states "In the event of extraordinary drought or serious accident to the irrigation system in the United States, thereby making it difficult for the United States to deliver the guaranteed quantity of 1,500,000 acre-feet (1,850,234,000 cubic meters) a year, the water allotted to Mexico under subparagraph (a) of this Article will be reduced in the same proportion as consumptive uses in the United States are reduced." The treaty does not define the term extraordinary drought.

When the United States Senate ratified the treaty in 1945, the conventional wisdom was that the average natural flow of the Colorado River at the international boundary with Mexico was about 18 million acre-feet per year.¹⁵ A delivery of 1,500,000 acre-feet per year represented about 8.3% of the river's natural flow. With a natural flow of 13 million acre-feet per year that same 1.5 million acre-feet per year is about 11.3%. Climate change has put the United States in a similar position as the Upper Basin. Both have fixed downstream obligations while climate change is reducing the water available in the river.

The perplexing question is; are the impacts of climate change an extraordinary drought or are they simply reducing the river to a "new normal"? Under minutes 319 and 323, Mexico has volunteered to take shortages. The parties have avoided making any conclusions concerning the

¹⁵ HD 419, Appendix I estimated the natural flow at Yuma at 17,720,000 acre-feet per year for the period of 1897-1943.

drought provision of the treaty. To complicate matters, if basin temperatures continue to increase, there may not be a “new normal.”

If the reality of climate change is going to be a factor in managing the post 2026 river, these two major unresolved issues related to the 1944 treaty with Mexico will have to be on the negotiating table.

The Battle over Ratification and a Realignment of the Basin States

The signing of the treaty with Mexico and Arizona’s ratification of the 1922 Compact changed the political alignment within the Colorado River Basin. Led by Colorado, the States of the Upper Division along with Texas were strong supporters of the treaty. California was adamantly opposed to it and was already planning its strategy to defeat it in the Senate. Arizona and Nevada were the swing states. Nevada would ultimately join with California and oppose the treaty, although its opposition would be nominal. Arizona, because under the 1928 act it shares the surplus with California, could have easily been an ally with California, but it was not interested in the surplus. Its primary interests were in protecting its development on the Gila River and securing a mainstream water supply for a project that could move water from Lake Havasu inland to central Arizona. California, not Mexico was its primary obstacle.

In *Dividing the Waters*, historian Norris Hundley suggests that Arizona may have agreed to support the treaty in exchange for Upper Basin’s help in its fight with California.¹⁶ Hundley makes this suggestion based on his interviews with those directly involved in the negotiations. In

¹⁶ Hundley, Norris Jr. *Dividing the Waters; a Century of Controversy between the United States and Mexico*. Berkeley, University of California Press, 1966, p. 130. Hundley amplifies his claim through footnote #70 on page 209.

researching *Science Be Dammed*, Kuhn and Fleck found a technical memo to the Colorado Water Conservation Board prepared by Royce Tipton which suggests that, indeed, Arizona and the States of the Upper Division reached a common technical understanding that they both believed would be in their long term best interests. That common technical understanding concerned an unresolved issue going back to the 1922 Compact negotiations – the definition of how the basin would measure apportionments. Tipton was making the case that the States of the Upper Division should support Arizona’s stream depletion theory. He referred to the hydrologic concept as “the salvage of water” or sometimes “salvage by use.”¹⁷

Now that Arizona had ratified the 1922 Compact, it was constrained by the mathematics of the compact and the 1928 act. Arizona took the position that the 1928 act gave it an Article III(a) apportionment of 2.8 million acre-feet per year, plus the 1922 compact negotiators had intended that it would be the beneficiary of the full one million acre-feet apportioned to the Lower Basin under Article III(b) for a total of 3.8 million acre-feet. However, it had plans to ultimately consume over five million acre-feet of Colorado River water. It was already consuming over two million acre-feet of water on the Gila River system.¹⁸ Additionally, the Bureau of Reclamation had already developed preliminary plans showing that a major conveyance project from the Colorado River main stem near Parker to central Arizona was technically feasible and, if big enough, economically feasible. This project would eventually

¹⁷ *Statement Concerning Miscellaneous Items Relating to the Colorado River*, By R. J. Tipton, Consulting Engineer for the Colorado Water Conservation Board, January 1945. Kuhn speculates that had Hundley been aware of the Tipton memo (and understood its significance), he would have had a much stronger case for his “collusion” theory.

¹⁸ The amount of actual Colorado River system water Arizona actually consumes from its tributaries is still a major mystery. As of the mid-1940s, the Bureau of Reclamation estimated that Arizona was consuming about 2.3 million acre-feet per year of Gila River surface water plus an additional 100,000 to 200,000 acre-feet from the Little Colorado. In addition to this, Arizona farmers were beginning to pump large amounts of groundwater in central Arizona. Undoubtedly, a portion of this groundwater is hydrologically connected to the Colorado River. In Colorado it would be considered tributary groundwater. However, under Arizona’s groundwater laws it may not be. The three million acre-foot number is a number Arizona, itself, used in the the 1930 Supreme Court case.

become today's Central Arizona Project (CAP). Including the CAP, Arizona's current and future main stem uses would consume their full 2.8 million acre-feet. Thus, Arizona's math problem was how to fit five million acre-feet of consumptive use into an apportionment of no more than 3.8 million acre-feet and minimize relying on surplus water. The answer was taking advantage of salvage by use by advancing its stream depletion theory of accounting.

In his memo to the Colorado Water Conservation Board, Tipton defines "salvage of water" as "the conversion of natural losses of water to beneficial use." He uses the Gila River system as the example of salvage by use showing that by diverting and consuming Gila River surface water upstream of the Phoenix area, it would be consuming over two million acre-feet per year, but only impacting the river at its mouth near Yuma by about a million acre-feet per year. He lays out Arizona's position, generally supports it, and suggests it's in the best interests of Upper Basin to support it as well.

A million acre-feet is the amount of water apportioned to the Lower Basin under Article III(b) of the Colorado River Compact. Arizona's position was that the entire one million acre-feet was for its benefit.¹⁹ Therefore, under its stream depletion theory, if 1922 Compact apportionments are measured as the impact to the river at the mouth and the entire million acre-feet of III(b) water was for the benefit of Arizona, it didn't need need to use surplus water, or at most, only a small amount.²⁰

¹⁹ Historically the States of the Upper Division had always been in general agreement with Arizona that the intent of the 1922 compact negotiators was that this million acre feet was intended to cover Arizona's uses on the Gila. Wyoming's Frank Emerson said it was in his January, 1923 report to the Wyoming legislature. Tipton states "apparently the records of the negotiations leading up to the drafting of and signing of the Colorado River Compact are clear that the million acre-feet of water appropriated by paragraph III(b) of the compact to the Lower Basin was to recognize existing beneficial consumption in the Gila River basin."

²⁰ With 2 million acre-feet of Gila River use only counting as one million acre-feet of apportionment, plus 2.8 MAF of mainstream use Arizona could use 4.8 MAF without turning to the surplus.

Why did Tipton suggest that it was in the best interests of the Upper Basin to agree with Arizona that for compact purposes, Lower Basin depletions (apportionment) should be calculated as the impact to the natural flow at the international boundary? The answer is that he believed the concept of salvage by use could be applied to the States of the Upper Division's Article III(a) apportionment of 7.5 million acre-feet per year.²¹ If depletions were measured at Lee Ferry, not at the points of upstream use, the Upper Basin could collectively use more than 7.5 million acre-feet per year. Tipton's concept of measuring depletions at Lee Ferry would soon be incorporated into the Upper Colorado River Basin compact.²²

The Senate hearings on the Treaty with Mexico would not begin until almost a year after it was signed, January 22nd, 1945. Of the eight states with interests in the treaty, six were in favor. Two, California and Nevada, were opposed. The hearings would last nearly a month. They were chaired by Texas Senator Thomas Connally, a strong supporter of the treaty.²³ Many technical issues, such as the amount of return flows and the actual uses in Mexico were debated, but there is very little serious discussion of the of the basic assumption by the treaty supporters that about 18 million acre-feet of water was available for use from the Colorado River system.

At the beginning of the hearing L. M. Lawson, the American Commissioner for the International Boundary Commission (IBC) and one of the lead U. S. negotiators presented an overview of the Colorado River basin that included information on the water supply. He presented information showing that the natural flow of the Colorado River at the international boundary was about 18 million acre-feet per year. IBC engineer Robert Lowery provided more

²¹ January 1945 Tipton Statement page 4.

²² Tipton Statement page 4. There are many ironies here. Tipton's reasoning was confusing at times. He adds "it is not presumed herein to attempt to interpret the Compact with respect to this item." Further, to help sell the Mexican Treaty, Tipton took the position that the Upper Basin would never fully consume its III(a) apportionment.

²³ Hundley in chapter 6, *Senate Battles, of Dividing the Waters*, does a nice job of describing the politics of the hearings.

detail on the 1944 estimate during his testimony he stated that eight million acre-feet of water flowed into Mexico unused and that it would be many years before users in the United States could use their full apportionments.²⁴

California put on an impressive set of witnesses who testified against the treaty, including Governor Earl Warren, who would later become Chief Justice of the U. S. Supreme Court, Attorney General Robert Kenny, former Congressmen and House sponsor of the 1928 Act Phillip Swing and a host of managers, attorneys and board member from its agencies that used Colorado River water. None of these witnesses would seriously challenge the underlying hydrology as presented by Lowery.

On Feb. 18, 1945, the Senate Foreign Relations Committee approved the treaty by a vote of 18 – 4 and passed it on to the full Senate. The Senate approved it by a vote of 76 – 10 on April 18, 1945, six days after the death of President Roosevelt. From the seven Colorado River Basin states and Texas, the Senate vote was 12-4 with the California and Nevada Senators voting nay. Mexico did not begin its ratification process until after the United States Senate had voted. In fact, the treaty was not even released to its public until two days before the U. S. Senate final vote. After, its own internal debate, Mexico's Senate ratified the treaty on September 27, 1945. The treaty entered into force on November 8, 1945.²⁵

Post Treaty Developments in the United States

²⁴ In *Science Be Dammed*, Kuhn and Fleck show that Lawson (with the help of Colorado's Tipton) seriously misled the Senate Committee by mixing actual and natural flows to argue there had been no downward trend in the natural flow of the river between 1922 and 1944. Lowery was right, it did take many years, but beginning in the early 2000s we got there, even with the Upper Basin only using about 4.5 million acre-feet, there is no surplus and California only has 4.4 million acre-feet available to it – at least for the foreseeable future.

²⁵ *Dividing the Waters*, page 169

After the Treaty with Mexico became effective and World War II ended, the development of the Colorado River within the United States accelerated. In the Upper Colorado River Basin, progress went smoothly. In 1948 the four States of the Upper Division and Arizona, which has a small amount of land in the Upper Basin, successfully negotiated the 1948 Upper Colorado River Basin Compact (1948 compact). During the negotiations and ratification of the treaty with Mexico was not a major issue. The 1948 compact is subject to (and subservient to) the 1922 compact, thus any obligations the Upper Basin had to Mexico were unchanged. True to the views of Royce Tipton and Arizona, Article VI of the 1948 compact defines how the Upper Basin is to measure its Article III(a) apportionment as the “man-made depletions of the virgin (natural) flow at Lee Ferry.”²⁶

The 1948 compact was followed in 1956 by Congressional approval of the Colorado River Storage and Participating Projects Act (CRSPA). This act authorized the Secretary of the Interior to construct and operate Glen Canyon Dam (which backs up Lake Powell) and three more large storage reservoirs totaling about 30 million acre-feet of storage. One of the primary purposes of these four reservoirs is to provide the carry-over storage necessary for the Upper Basin to meet its 1922 compact obligations to the Lower Basin and Mexico. By 1956, although early hydrologists and engineers who had warned of shortfalls were long forgotten figures from the 1920s, their conclusions concerning the long-term average natural flow of the Colorado River at Lee Ferry had been proven right. By the late 1950s, the average natural flow at Lee Ferry had dropped to about 15.1 million acre-feet per year. This reality made the case for the construction

²⁶ This was not an easy decision. During the debate, Wyoming’s legal advisor, William Wehrli, argued that this definition would hurt the Upper Basin because it would decrease the surplus and thus increase the amount of the deficiency under Article III(c). He was right. During the ratification of the 1948 Compact, California objected to this definition, but ended up accepting a committee statement that ratification of the compact by Congress was not an interpretation of the 1922 compact or the 1928 act.

of storage above Lee Ferry more urgent. Upper Basin water officials now recognized that they had to have large amounts of storage in place to develop even six million acre-feet per year.²⁷ At the basin level, it meant that there was no longer any surplus available for further apportionment under Article III(f) of the 1922 compact, which had called for the states to reassemble fifty years after the Compact's approval to allocate the remaining unused water. October 1st, 1963 came and went with no call for further apportionments and no debate.

In the Lower Basin, things were not as smooth. Arizona's priority was the authorization of the Central Arizona Project. However, due to the uncertainty concerning the water supply available to this multi-billion-dollar project and California's opposition, Congress refused to act. In 1952 Arizona went to the Supreme Court. Among the disputed issues were the meaning of Article III(b), how apportionments were to be measured under the 1922 compact, and how Lower Basin mainstream reservoir evaporation should be attributed to the states of the Lower Division. Arizona's position was that the entire one million acre-feet apportioned to the Lower basin under Article III(b) was for its benefit, giving the state a total apportionment of 3.8 million acre-feet.²⁸ It further claimed that apportionments were to be measured by its stream depletion theory, the net impact of upstream depletions on the virgin flow of the river at the international boundary. This strategy gave Arizona the ability to use a full two million acre-feet of Gila River water in addition to 2.8 million acre-feet of mainstream water.²⁹ Arizona further claimed that Lower Basin main stem reservoir evaporation should be charged in proportion to each state's 1928 act apportionments.

²⁷ The first formal public recognition that the Upper Basin had less than 7.5 MAF/year came from the report "Depletion of Surface Water Supplies of Colorado West of Continental Divide" by Leeds, Hill, and Jewett, dated Oct 31, 1953. This report was written before the full effects of the 1953-1964 drought became apparent.

²⁸ Arizona acknowledged that New Mexico and Utah were entitled to a small amount of water (about 130,000 acre-feet per year) to cover uses on upper Gila and Virgin Rivers.

²⁹ Existing (and senior) mainstream uses in Arizona totaled about 1.2 million acre-feet per year, giving the CAP up to 1.6 million acre-feet of potential annual diversions.

California took the position that the Article III(b) water was not limited to Arizona and that lacking a Lower Basin compact, through its Hoover Dam water contracts it had appropriated at least a portion of that million acre-feet. Its case also relied on its diversions-minus-return-flows theory. If all of Arizona's two million acre-feet (plus) of consumptive use on the Gila River counted as apportionment, even if the court ruled in favor of Arizona on Article III(b), Arizona's main stem diversions would be limited to 1.8 million acre-feet per year, freeing up water for its contract use (and probably making the CAP economically unfeasible).³⁰

In perhaps a much under-reported and misunderstood way, the case would turn on a failure of the first Special Master to understand the 1922 compact provisions related to Mexico. After the case was filed, Arizona and the States of the Upper Division took the position that this was a Lower Basin case only and thus, there were no Upper Basin issues or basin-wide 1922 compact issues of dispute. California countered by making the case that Arizona's stream depletion theory of accounting was a basin-wide 1922 compact issue. Specifically, California pointed out that under the stream depletion theory, the available surplus would be less, making the deficiency greater, thus increasing the amount of water the States of the Upper Division would have to deliver to Mexico under Article III(c). In retrospect, California was obviously right. From today's perspective it's difficult to understand why the States of the Upper Division were so adamant about staying out of the case. It raises the question of whether or not they were living up to their end of the 1945 deal with Arizona on the Mexican Treaty.³¹

³⁰ With a total apportionment of 3.8 million acre-feet, but at least 2 million acre-feet of apportioned use on the Gila, its mainstem supply would be 1.8 million acre-feet. Arizona's main stem uses in the Yuma area and its share of reservoir evaporation would be about 1.5 -1.6 million acre-feet per year, leaving only 200,000-300,000 acre-feet for the CAP.

³¹ Early in his career Kuhn asked long time former Colorado CWCB director and UCRC commissioner Felix Sparks why the Upper basin stayed out of the case. His answer was (very Sparks-like) "because we were &*&^\$# stupid!" In *Science Be Dammed*, Kuhn and Fleck show that the States of the Upper Division were primarily concerned with how their participation in the case would impact Congressional approval of CRSPA.

Arizona and the States of the Upper Division would prevail with Special Master George Haight. He ruled, and the Supreme Court upheld, that this case involved no basin-wide compact issues. This effectively took the 1922 compact issues off the table and made it a case concerning only the intent of Congress in passing the 1928 act. In its initial complaint, Arizona filed five claims for relief related to the 1922 compact. It would not prevail on any of one of them, but would win the case. The unresolved issues concerning the interpretation of Article III(b), how apportionments are measured, and how main stem reservoir evaporation should be charged under the 1922 compact remain unresolved today.

In 1963 the Supreme Court ruled that through the 1928 act, Congress put in place an apportionment of the Lower Basin main stem water in and below Lake Mead, giving Arizona 2.8 million acre-feet per year. This decision made the CAP feasible, but it still needed to be authorized by Congress. After five years of debate, in 1968, Congress passed the Colorado River Basin Project Act authorizing the construction and operation of the Central Arizona Project. The United States obligation to Mexico became a major issue of controversy during the Congressional debate.

By the mid-1960s, there was little debate that the long-term average natural flow at Lee Ferry was about 15 million acre-feet per year and that the long-term average natural flow of the river at the international boundary was in the range of 16 to 16.5 million acre-feet per year.³² During the Congressional debate over the authorization of the CAP, almost every basin water official who testified came to the same conclusion - that the river was over-allocated and there

³² There have been no comprehensive reconstructions of the natural flow at the border since the early 1950s. One can arrive at a natural flow by using the assumption that the natural flow of the river at Lee Ferry and Laguna (now the Imperial Irrigation District Diversion Dam) are about the same and adding one million acre-feet for the natural flow of the Gila River. The Bureau of Reclamation's current natural flow data base estimates natural flows down to Imperial Dam and shows gains between Lee Ferry and Imperial as over one million acre-feet per year, in part because stream losses below Hoover Dam are now shown as a demand on the system. We have very little confidence in the data below Hoover Dam.

was not enough water to meet future needs. The Bureau of Reclamation's solution was to propose augmenting the Colorado River by importing water from the Columbia River Basin. Under title II of the 1968 Colorado River Basin Project Act, which authorized the CAP, Congress declared "the satisfaction of the requirements of the Mexican Water Treaty constitute a national obligation which shall be the first obligation of any water augmentation project....(planned pursuant to this act and authorized by Congress)...." The problem was, of course, that by the time the 1968 act passed an augmentation project from the Northwest was pie-in-the-sky and according to former Congressman and House Natural Resources Committee Chair Wayne Aspinall "we all knew it would never be built."³³

The combination of the 1963 Supreme Court decision in *Arizona v. California* and the 1968 authorization of the CAP locked in place the ultimate overuse of Colorado River water by the states of the Lower Division. From the 1970s to about 2000, conditions were generally wet, although nowhere near as wet as the early 1900s, the average natural flow at Lee Ferry from 1971 – 2000 was 15.25 million acre-feet per year. The 1980s became the wettest decade since the 1920s. During that time population growth throughout the basin boomed. In the Lower Basin the CAP was completed and went into full operation and water use in Southern Nevada skyrocketed as it used its full 300,000 acre-feet of apportionment. On the Colorado River, after the water quality issues of the early 1970s were settled by Minute 242 and the Salinity Control

³³ See *Science Be Dammed*, chapter 16. Aspinall was the House Natural Resources Committee Chairman during the debate over the CAP. His home was Palisade, Colorado. Throughout his political career he was a close friend and ally of Eric Kuhn's employer, the Colorado River Water Conservation District. In the early 1980s Eric had the great pleasure of driving him to several Club 20 meetings. When he wasn't sleeping, he had some very entertaining stories. He described Title II as "BS" to make everyone feel good. He said they all knew that the Pacific Northwest states (led by Senator Scoop Jackson) would never allow a big project to export water to the Colorado River Basin. By the early 1980s Aspinall was also quite firm in his belief that, unless big oil shale projects needed it, the Upper Basin would never use close to six million acre-feet per year. He commented that Western Colorado was being run over by new (and young) immigrants from other states who wanted to live and play here. The idea that we need to subsidize irrigation to settle the west "ended in the 50s."

Act, like the water supply conditions, the relationship between the United States and Mexico was generally good. This became the perfect setup for the shock of the drought of 2000-2004.

The 2007 interim Guidelines, Minutes 319 and 323, and the Drought Contingency Plans

As the twentieth century ended and the twenty first began on January 1st, 2000, the large reservoirs on the Colorado River system were essentially full. Hydrologic conditions in the late 1990s were wet. Annual inflows to Lake Powell in water years 1997, 98, and 99 were all above average. Beginning with 2000, conditions turned very dry causing storage levels in Lake Powell to plummet. For the five-year period of 2000-2004, the natural flow at lee Ferry averaged just 9.46 million acre-feet per year (63% of normal). Active storage in Lake Powell bottomed out in March 2005 at a bit less than eight million acre-feet. Because of the minimum objective release of 8.23 million acre-feet per year, storage in Lake Mead dropped at a slower, but still unacceptable rate. In 2002, California agencies used almost 5.3 million acre-feet of Lake Mead water. In 2003, Secretary Gail Norton cut California back to its basic 1928 act apportionment of 4.4 million acre-feet per year.

The drought also triggered the development of formal shortage criteria. Under the 2007 Interim Guidelines, annual shortages to Lake Mead contract holders are set based on the projected end-of-calendar storage level in lake Mead. The maximum shortage level is capped at 500,000 acre-feet for U.S. users.³⁴ As contemplated by the 1968 Colorado River Basin Projects Act, the Central Arizona Project takes the brunt of shortage, about 91%.

³⁴ The Environmental Impact Statement contemplated a maximum shortage of 600,000 acre-feet if the end-of-year storage in Lake Mead was projected to be below elevation 1025', 500,000 acre-feet within the U.S. and 100,000 acre-feet for Mexico.

From 2005-2011, natural inflows to Lake Powell were slightly above the long-term average, 15.06 million acre-feet per year. Storage in Lake Powell recovered to the point where after the 2011 big runoff year, almost five million acre-feet of equalization water was delivered downstream to Lake Mead. After the big 2011 year, the basin plunged back into a two-year drought.³⁵ In the summer of 2013, the basin states met with Secretary Sally Jewell and agreed to begin the process of preparing drought contingency plans. Flows returned to about average for the 2014-2019 period, about 14 million acre-feet per year.³⁶ This was enough to recover a little storage in Lake Powell sufficiently to make annual releases of 9 million acre-feet per year pursuant to the 2007 Interim Guidelines. Together with a modest conservation program in the Lower Basin to reduce consumptive uses, the 9 million acre-feet annual releases have kept Lake Mead levels above the first-tier shortage trigger of elevation 1,075’.

The DCPs for each basin were completed in the spring of 2019 when President Trump signed the federal legislation directing the secretary of the Interior to implement the plans. Under the Lower Basin DCP the three States of the Lower Division have agreed to implement additional conservation measures to reduce demands (increase the prescribed shortage levels) for Lake Mead water based on active storage in Lake Mead. If the storage levels in Lake Mead are projected to drop below elevation 1025’, the total reduction in demand for Lake Mead water (including the 500,000 acre-feet of 2007 Interim Guidelines shortages, the conservation required by the DCP, and Mexico’s reductions under Minute 323) will exceed 1.3 million acre-feet per year. The Lower Basin DCP can be considered groundbreaking for several reasons. First is the coordination of the Lower Basin DCP conservation actions in Mexico. Second, the State of

³⁵ Total natural flow for water years 2012 and 2012 was 17.41 million acre-feet, the third driest two-year period behind 1976-77 and 2001-2.

³⁶ The 14 million acre-feet per year average is based on the Natural Flow Data Base for water years 2014-16 and preliminary estimates for water years 2017-19.

California has agreed, for the first time, to take shortages, despite what was contemplated by the 1968 act.

The Upper Basin DCP is more modest than the Lower Basin DCP. Its two primary provisions are drought operations of the upstream CRSPA storage reservoirs, Flaming Gorge, Blue Mesa (Aspinall Unit), and Navajo, to supplement storage levels in Lake Powell, an action that was contemplated when these reservoirs were authorized,³⁷ and a commitment to study the implementation of a demand management program in the Upper Basin. Although it is contemplated that an Upper Basin demand management program would be coordinated, likely through the Upper Colorado River Compact Commission, each of the four states will have to make the decision to implement the program within its state. Given the costs and complexities of implementing a demand management program, these decisions will be very difficult.

The common denominator for the 2007 Interim Guidelines, Minute 323, and the Upper and Lower Basin DCPs is that they all expire at the end of 2026.³⁸ In theory, how the river will be managed beginning with water year 2027 will begin with a clean slate.³⁹ Presumably, that clean slate will include the unresolved issues related to the Upper Basin's obligation to Mexico under Article III(c) of the 1922 compact and the extraordinary drought provision of the treaty with Mexico.

³⁷ For example, the 1959 Economic Justification Report for the Curecanti Unit (now Aspinall), prepared by the Department of the Interior took advantage of the basin-wide benefits from making releases to help meet the Upper Basin's obligations at Lee Ferry when there is not enough stored water in Lake Powell.

³⁸ The conserved water recovery provisions of the LB DCP go beyond 2026.

³⁹ There is always the possibility, if not a probability, that if there is no basin-wide agreement on new guidelines, the river operations could revert to the pre-2007 Annual Operating Plan rules or, much more likely, the 2007 Interim guidelines (probably with the DCPs and perhaps an extended Minute 323) could be extended on a temporary basis while negotiations continue.

Possible Interpretations of the Upper Basin's Article III(c) Obligation to Mexico

Several different possible interpretations of the Upper Basin's obligation to Mexico under Article III(c) have been put forth by legal experts, state water officials, and water agency representatives. For this paper, we have identified three basic alternatives, but each alternative has several different variations depending on how apportionments under the 1922 compact are measured and the amount of water supply available in the river.

The three basic alternatives are:

1. The plain reading of Article III(c); The surplus is defined as the amount of long-term Colorado River system water available over the total apportionments made in Articles III(a) and (b), or 16 million acre-feet. This alternative is referred to as the "plain reading."
2. The Upper Basin's unused apportionment first goes to Mexico; Under this alternative, the surplus is the amount of water over the sum of lesser of each basin's apportionment or each basin's actual use. In this case since the Lower basin is using over 10 million acre-feet and the Upper Basin is using about 4.5 million acre-feet per year, the surplus is the amount of Colorado River system water available over 13 million acre-feet per year (8.5 + 4.5). This alternative is referred to as the "unused apportionment goes to Mexico."
3. Implementation of Article III(c) reduces each basin's 1922 compact apportionments; If the long-term Colorado River system water available is less than 17.5 million acre-feet per year, it reduces each basin's apportionment under Article III(a) and (b) by 50% of the difference between the available water supply and 17.5 million (up to the 1.5 million

acre-feet delivery). For example, if the long-term available water supply is 16.5 million acre-feet per year, then the Upper and Lower Basin apportionments would be reduced by $((17.5-16.5)/2 \text{ or } 500,000)$ to 7 million acre-feet for the Upper Basin and to 8 million acre-feet for the Lower Basin. This alternative is referred to as the “reduced apportionments.”

The Dispute over Measuring Apportionments under the Colorado River Compact

For each of the above three alternatives, the term “long-term Colorado River system water available” can be calculated in one of two different ways depending on how compact apportionments are measured under the 1922 compact.

In the 1940s and 1950s Arizona and the States of the Upper Division developed and advocated for what is called the “stream depletion” theory of apportionment accounting. Under this theory apportionments are measured as the net impact of upstream depletions on the natural (virgin) flow of the river at the international boundary for the Lower Basin and at Lee Ferry for the Upper Basin. Arizona first championed this definition because it would allow the state to take advantage of about a million acre-feet of “salvage by use” water on the Gila River system.

The Gila River has its headwaters along the Mogollon Rim and in the mountains of Central Arizona and Western New Mexico. As the Gila and its principal tributaries, the Salt and Verde River leave the rim country, their collective natural flow is about 2 million acre-feet per year. However, as it flows south and west from the Phoenix area through one of North America’s driest and hottest deserts to its confluence with the Colorado River at Yuma it loses about a million acre-feet per year to evaporation and native vegetation. By fully using the Gila River

water upstream, Arizona water users can consume 2 million acre-feet of water per year, but only have an impact to the natural flow of the Colorado River at Yuma of about 1 million acre-feet.

In the late 1940s as Arizona struggled to overcome California's Congressional opposition to the authorization of the Central Arizona Project (CAP), the stream depletion theory of accounting was essential to its strategy. Arizona laid out this strategy in its formal comments to the comprehensive development plan for the Colorado River, House Document 419. Arizona's argument was that the 1922 compact limited the Lower Basin to 8.5 million acre-feet per year of apportionment. Since the Boulder Canyon Project Act (1928 act) and the California Limitation Act limited California to 4.4 million acre-feet, Arizona concluded 4.1 million acre-feet was left for the remaining four states. Giving Nevada the 300,000 apportioned to it by the 1928 act and allowing for a total of 131,000 acre-feet of depletions by Utah in the Virgin River basin and New Mexico in the headwaters of the Gila River (both Lower Basin tributaries), Arizona was left with 3.669 million acre-feet per year that it could use under the 1922 compact.

Using its stream depletion theory of accounting, Arizona calculated it was only using 1.407 million acre-feet per year, leaving 2.262 million acre-feet of apportionment available for future use on the mainstream. Arizona allocated 600,000 acre-feet for the Gila project, 1.1 million acre-feet for a Central Arizona Project, and the remainder (562,000) for future use and to cover its share of evaporation on the Lower Basin's main stem reservoirs.⁴⁰

California offered a very different and more conventional method of measuring apportionments, the "diversions-less-return-flows" theory. Under this theory, the apportionment used by each basin is the sum of the consumptive uses, all of the individual diversions for

⁴⁰ Arizona's arguments are spelled out in its November 22, 1946 comment letter signed by Governor Sidney Osborn and included in HD 419, pages 15-18. For more information, see *Science Be Dammed*, Chapter 12.

irrigation, domestic (broad definition pursuant to Article II(h) of the 1922 compact), and exports out of the drainage basin as measured (or estimated) by diversions minus return flows.

Under California's theory of accounting Arizona was using about 2.3 million acre-feet of apportionment on the Gila River alone. California's theory meant that system water that becomes available through salvage by use is accounted against each basin's 1922 compact apportionment.⁴¹ Led by Colorado, the States of the Upper Division agreed with Arizona's stream depletion theory of accounting. As we have seen, the theory was incorporated into the 1948 Upper Colorado River Basin Compact. Under Article VI the Commission determines the quantity of consumptive use of water for the Upper Basin and for each state "in terms of man-made depletions of the virgin (natural) flow at Lee Ferry...."

Based on the official *Record of the Commission*, the reason the States of the Upper Division agreed with Arizona's stream depletion theory of accounting is quite clear. They believed that the Upper Basin could benefit from salvage by use. The commission's engineering committee had concluded that while the average natural flow of the Colorado River at Lee Ferry was 15.63 million acre-feet per year, the sum of the natural flows at the individual state lines was 16.23 million acre-feet per year.⁴² Thus, like Arizona's Gila River, by consuming water upstream of Lee Ferry and by measuring that consumption as the impact of upstream depletions on the natural flow of the river at Lee Ferry, they could (at least during wet periods) consume more than 7.5 million acre-feet per year under their Article III(a) of the 1922 compact.

⁴¹ California's arguments are spelled out in its February 7, 1947 letter signed by Assistant State Engineer A. D. Edmonston and included in HD 419, pages 19-57.

⁴² See Record of the Commission Volume III

The record shows that during the 1948 compact deliberations, this decision was not totally accepted. Wyoming legal advisor William J. Wehrli pointed out that this definition could decrease the surplus and therefore increase the amount of water the Upper Basin would have to deliver to Mexico under Article III(c).⁴³

In 1952, when Arizona filed its supreme court suit, one of its claims for relief was that the court find that its stream depletion theory was the appropriate method for measuring apportionments under the 1922 compact. When Arizona filed the suit, it appeared that the 1922 compact was headed for interpretation by the court. However, as the case progressed, the court changed directions and limited the case to the interpretation of the Boulder Canyon Project Act. In 1957, Arizona amended its filing, dropping any mention of its stream depletion theory. Thus, the court has never ruled on whether Arizona's stream depletion theory or California's diversions-less-return-flows theory is the appropriate method of accounting for apportionments under the 1922 compact.

Based on a discussion of the 1922 compact provided by Special Master Simon Rifkind as background, we do know how he would have ruled had the issue been in front of him. Rifkind clearly favored California's diversions-less-return-flows method. In his background opinion he states "As used in the Compact, beneficial consumptive use was intended to provide a standard for measuring the amount of water each basin might appropriate. This was necessary since Article III(a) and (b) impose limits on appropriative rights. The term beneficial consumptive use as employed in the Compact was intended to give each Basin credit for return flow. Thus, whether the limits fixed by Articles III (a) and (b) have been reached or exceeded is to be

⁴³ See Record of the Commission Volume II, minutes of the 7th meeting. Werhli was also skeptical the 1922 compact negotiators intended to apportion depletions as opposed to consumptive use.

determined by measuring of each Basin's total appropriations through the formula, diversions less return flows."⁴⁴

In *Arizona v. California* Arizona's R. I. Meeker provided testimony that as an advisor to Colorado's Delph Carpenter, he attended all the Santa Fe negotiating meetings and he believed the intent of the 1922 compact commissioners was to measure apportionments as the net impact of upstream depletions at the international boundary for the Lower Basin and at Lee Ferry for the Upper Basin.⁴⁵ However, the minutes of the 1922 compact and ratification proceedings provided little support for that position. In his December 15, 1922 report to Governor Oliver Shoup and Colorado's General Assembly, with Meeker's assistance, Carpenter provides a table that shows the "estimated average available water supply" from the Colorado River as 20.5 million acre-feet per year, with 17.5 million originating above Lee Ferry and 3 million originating below Lee Ferry from Lower Basin Tributaries.⁴⁶ We don't know if by using the term "available water supply" Carpenter was referring to the natural flow of the river at the international boundary or the total water supply that could be used including by taking advantage of salvage by use. However, the only reasonable way he could have concluded 3 million acre-feet of water was available from the Lower Basin tributaries was by including water made available through salvage.

In Carpenter's March 20, 1923 supplemental report, he includes a paragraph titled "Beneficial Consumptive Use".⁴⁷ In this paragraph he notes 'the measure of the apportionment is the amount of water lost to the river. The "beneficial consumptive use" refers to the amount of

⁴⁴ Report of the Special Master in the *Arizona v. California* case 364 U. S. 940, January 16, 1961, pages 147-8.

⁴⁵ As a technical advisor to Arizona during the negotiations of the 1948 compact, Meeker made the same statement to the Upper Basin's commissioners and advisors.

⁴⁶ Hoover Dam Documents, Tables 1 and 2, page A82

⁴⁷ Hoover Dam Documents page A102.

water exhausted or lost to the stream in the process of making all beneficial uses. As recently defined by Director Davis, of the United States Reclamation Service, as “diversion minus return flow.”⁴⁸ Carpenter’s words can probably be used to make an argument for either theory.

We do know that throughout the minutes of the 1922 compact meetings, in most of the written reports, and in the language of the compact itself, the commissioners often refer to “apportionments for beneficial consumptive use”. There is no mention of “stream depletions” in the context of making apportionments. There are several instances where the written reports of the commissioners or advisors appear to support California’s diversions-less-return-flows theory. In an article for the Arizona Mining Journal, January 15, 1923, Arizona legal advisor Richard Sloan notes that the total possible consumptive use of 2,350,000 acre-feet from the Gila and its tributaries would be included within the 8.5 million acre-feet allotment to the Lower Basin.⁴⁹ By assuming a consumptive use of that amount, Sloan is clearly not using the stream depletion theory.

Since the concepts of estimating natural flows, using them for planning purposes, and the technical nuances of salvage by use were not commonly understood or used before the 1920s, the commissioners and their advisors simply may have had a no understanding of the topic, and therefore, they did not define how compact apportionments were to be measured.

By the time the treaty with Mexico was the subject of Senate confirmation in 1945, the question of how apportionments are measured under the 1922 compact was a matter of critical importance to the future of the basin. At that time, the best estimate of the natural flow of the

⁴⁸ Wilbur, Ray Lyman, and Northcutt Ely. *The Hoover Dam Documents*. No. 717. Washington, D.C.: Government Printing Office, 1948. page A48

⁴⁹ Sloan’s article is reprinted in the *Hoover Dam Documents*, see page A69.

Colorado River at the international boundary was 17.72 million acre-feet per year.⁵⁰ Under Arizona's stream depletion theory, since Articles III(a) and (b) apportioned a total of 16 million acre-feet and the treaty with Mexico another 1.5 million acre-feet per year, the surplus was only 220,000 acre-feet per year. Under California's theory, salvage by use creates another 1.5 – 2.0 million acre-feet per year of upstream consumptive uses⁵¹ that count as apportioned uses under the 1922 compact, therefore, increasing the surplus by that same amount. Under Arizona's theory there was water for the CAP, but little surplus for California. Under California's theory, there was enough surplus to satisfy its 5.3 million acre-feet of contracts, but probably not enough for Arizona's CAP.

Although how apportionments are to be measured under the 1922 compact has never been legally resolved and is a dispute that has now been largely forgotten, on today's river with a flow diminished by climate change, for determining the Upper Basin's obligation to Mexico under the 1922 compact, it still may be critically important.

Analysis of Each Alternative Under Different Hydrologic and Apportionment Accounting Assumptions

For comparison purposes, our three alternative interpretations for the Upper Basin's obligation to Mexico are analyzed under three different hydrologic scenarios. Further, each

⁵⁰ HD 419, Appendix I, page 284

⁵¹ The total salvage by use water thought made available for consumptive uses in the 1940s was about one million acre-feet per year on the Gila River system, another 400,000 acre-feet on the main stem of the Colorado River, and up to 600,000 acre-feet above Lee Ferry. There is not much debate that salvage by use creates additional water for consumptive use on the Gila River system, but the authors are not aware of any definitive studies suggesting large salvage by use gains between Hoover Dam and Imperial Dam and upstream of Lee Ferry. We suspect that today, the total may be about 1 million acre-feet per year.

hydrologic scenario will be analyzed under the two different methods for measuring apportionments, the stream depletion theory (which means water made available through salvage by use is NOT counted against each basin's 1922 compact apportionment) and the diversions-less-return-flows theory (which means water used through salvage by use IS counted against each basin's 1922 compact apportionment).

The three hydrologic scenarios are:

1. An assumed long-term average natural flow of the Colorado River at the international boundary of 16 million acre-feet per year. The additional water consumption through salvage by use is 1 million acre-feet per year. This scenario is roughly based on the Natural Flow Data Base 1906 – 2016 period of record. The average natural flow at Lee Ferry over this period is 14.8 million acre-feet per year. Assuming the average natural flow at Lee Ferry and Laguna Dam are about the same and that the long-term natural of the Gila River is about 1 million acre-feet per year, the system natural flow from 1906-2016 averaged about 16 million acre-feet per year.

2. An assumed long-term average natural flow of the Colorado River at the international boundary of 14 million acre-feet per year. The additional water consumption through salvage by use is 800,000 acre-feet per year. This scenario is roughly based on what is now referred to as the “stress test” period of 1988-2016. The average natural flow at Lee Ferry over this period about 13.1 million acre-feet per year (NFDB). With the same assumption that the average annual natural flows at Lee Ferry and Laguna Dam are

about the same and assuming the natural flow of the Gila River is about 800,000 acre-feet per year⁵², the system natural flow is about 14 million acre-feet per year.

3. An assumed long-term average natural flow of the Colorado River at the international boundary of 12 million acre-feet per year. The additional water consumption through salvage by use is 600,000 acre-feet per year. This scenario assumes that climate change will continue to diminish the flow of the Colorado River system. This scenario is drier than the current 2000-2019 period, which has an estimated average natural flow at the international boundary of about 13 million acre-feet per year, but well within a reasonably foreseeable future with climate change.

For all three scenarios our assumption is that the total consumptive use in the Upper Basin, including reservoir evaporation, is 4.5 million acre-feet per year, and in the Lower Basin, including reservoir evaporation and tributary use is over 10 million acre-feet per year.⁵³

Summary of the Alternatives

Of the three alternatives presented, the “plain reading” and “unused apportionments first go to Mexico” are the two serious alternatives that deserve further scrutiny.⁵⁴ The plain reading alternative will have supporters in the Lower Basin. A 2012 analysis by the Colorado River

⁵² Being the southernmost tributary of the Colorado River system and with a relatively low elevation watershed, the Gila River is likely to be one of the stream systems most impacted by climate change. As the yield of the Gila is reduced, the water available from salvage by use will be reduced as well. Therefore, under the reduced flow scenarios, it made sense to the authors to also reduce the amount of salvaged water.

⁵³ The Bureau of Reclamation estimates and publishes data on consumptive uses in the basin in what is referred to as the “Consumptive Uses and Losses Report.” The most recent provisional data available for the Upper Basin is 2016. Unfortunately, the most recent data on the Lower Basin tributaries is 2005.

⁵⁴ The reduced apportionments theory was advocated by the UCRC in the 1970s, but has received little attention since then.

Governance Initiative concluded that the alternative had a strong legal foundation.⁵⁵ Under most hydrologic assumptions and under either theory of apportionment accounting, implementation of this alternative would favor the Lower Basin.

The “unused apportionment goes to Mexico” alternative also has support, including Colorado’s James Lochhead⁵⁶ and, arguably, Special Master Simon Rifkind’s 1961 report. Under the hydrologic conditions the basin has experienced since the late 1980s or wetter, (14 million acre-feet per year scenario) and using the diversion-less-return-flows theory of apportionment accounting, implementation of this alternative eliminates any obligation of the Upper Basin to Mexico under Article III(c). Under the stream depletion theory of accounting, the Upper Basin’s obligation is reduced by 500,000 acre-feet per year, but not eliminated. Under drier future alternatives (an average natural flow at the international boundary of 12.5 (plus or minus) million acre-feet per year⁵⁷, the advantage of this alternative to the Upper Basin goes away.

From a technical standpoint, both alternatives raise serious concerns, as do both theories of apportionment accounting. First, as previously mentioned, the Natural Flow Data Base does not include the Gila River system. Without modeling the Gila River system, we can’t make a good estimate of the natural flow of the Colorado River at the international boundary. We need to know this number to use both alternatives. Expanding the Natural Flow Data Base to include the Gila would be a very challenging technical task. As pointed out in the Consumptive Uses and Losses Report, distinguishing between surface water use and ground water use, determining how much of existing groundwater use is tributary to the Colorado River system, and estimating

⁵⁵ Colorado River Governance Initiative. "Respective Obligations of the Upper and Lower Basins Regarding the Delivery of Water to Mexico: A Review of Key Legal Issues." (2012). <http://www.waterpolicy.info/wp-content/uploads/2015/09/Obligations-Regarding-the-Delivery-of-Water-to-Mexico.pdf>

⁵⁶ Lochhead, James S. "An Upper Basin Perspective on California's Claims to Water from the Colorado River Part I: The Law of the River." *University of Denver Water Law Review* 4 (2000): 290..

⁵⁷ This is not much drier than the current average natural flow at Lee Ferry for the period of 2000-18, which probably had a natural flow at the international boundary of about 13.1 million acre-feet per year.

natural losses in Central Arizona are very complicated and controversial technical computations. Further, Arizona has always opposed including the Gila River system in systemwide models or in systemwide studies, such as the 2012 Colorado River Supply and Demand study. Any effort to estimate the natural flow of the Colorado River at the international boundary will require Arizona's cooperation and support – and that may never happen.

A second problem is that we don't have a good understanding of natural losses to the river between Hoover Dam and Yuma. The current version of the Natural Flow Data Base shows that reach to be gaining. The 1906-2017 natural flow at Hoover Dam averages 15.66 million acre-feet per year. At the Imperial Diversion Dam, it is 16.09 million acre-feet per year. In contrast, the hydrologic appendix to HD 419 (1897-1943) showed that under natural flow conditions the river, a loss of over 1 million acre-feet per year in that stretch.⁵⁸ According to Reclamation officials, the river losses in that stretch are modeled as a demand on the system and the modelers have very little confidence in how CRSS handles losses in that stretch of the river.⁵⁹

Since determining the Upper Basin's obligation to Mexico under both the plain reading and the surplus apportionment first goes to Mexico alternatives requires a good understanding of the natural flow of the river at the international boundary, both CRSS and the underlying consumptive use data will require considerable improvement.

A third major problem is determining and having confidence in basin-wide depletions. We know of no recent studies that have attempted to determine depletions in either basin under the stream depletion theory of accounting. The Upper Colorado River Compact Commission engineering advisory committee put together what is referred to as the "input-output" manual which describes a rudimentary process for determining Upper Basin depletions under the stream

⁵⁸ HD 419, Appendix I

⁵⁹ Personal communication between Eric Kuhn and Dr. James Prairie.

depletion theory, but it relies on stream flow – consumptive use correlations that were made over 70 years ago and with very limited data. Further, when the input-output manual was prepared, the hydrologists at the time did not have a good understanding of the complex interaction between surface water flows and tributary groundwater. Indeed, under today’s standards, the basic logic of the input-output manual - measure and sum the flow of every input stream in a basin, then subtract the measured output at the bottom of the basin (Lee Ferry for the Upper Basin) - may not even be considered feasible.⁶⁰

Bureau of Reclamation personnel are continually working to improve the Consumptive Uses and Losses Report methodology, but it is a challenging and slow process. The latest published data on Lower Basin tributary use are now almost 15 years old.⁶¹ The States of the Upper Division and Reclamation are cooperating on improving consumptive use data, but the process will take years.⁶²

The technical and political problems associated with calculating the average natural flow of the Colorado River at the international boundary are so daunting that it brings up what can only be referred to as the “default alternative” – because of the technical problems associated with a more rigorous determination of the Upper Basin’s obligation to Mexico under Article III(c), and because it’s a road that could quickly lead to litigation, let’s just all agree that the

⁶⁰ We now understand that during the baseflow period, most flow originates as tributary groundwater which accrues (or goes back into the ground) for the entire stream length.

⁶¹ One of the political problems the Bureau of Reclamation faces in the Lower Basin is that because of the long-standing basin-wide dispute over the status of the Gila diversions, there is little incentive for the States of the Lower Division to cooperate.

⁶² The states and Reclamation are evaluating a gradual move that would calculate consumptive uses based on Penman-Montieth instead of modified Blaney-Criddle. It’s been understood for many years, that modified Blaney-Criddle is outmoded, but collecting the weather data necessary for Penman will take time. It’s also been long recognized that the different methodologies: modified Blaney-Criddle, modified Blaney-Criddle with elevation corrected crop coefficients, satellite-based infrared measurements, and Penman-Montieth, all give very different answers for consumptive use. A change in consumptive use data will alter the calculation of natural flows. When (if) such a change occurs, many dominoes will fall.

Upper Basin's obligation to Mexico is 750,000 acre-feet per year and move on to solving the other problems on the river. It's a compelling argument, but facing a decision to implement a costly and politically divisive demand management program, should the Upper Basin accept the default alternative or should it ask for something more from the Lower Basin?

Are We in an “Extraordinary Drought Under the Treaty with Mexico?”

The second major policy issue related to Mexico that could impact the post 2026 Colorado River is the “extraordinary drought” provision under Article 10 of the 1944 treaty. Under this provision of the treaty during such an extraordinary drought, the water allotted to Mexico will be reduced in the same proportion as consumptive uses in the United States are reduced. The term “extraordinary drought” is not defined. Under Minutes 319 and 323 to the U.S.-Mexico water treaty, Mexico agreed to accept shortages based on the level of storage in Lake Mead under the same elevation triggers that set shortages for users in the United States. The shortages accepted by Mexico are voluntary and not considered an interpretation of the treaty.

While the treaty does not define extraordinary drought, the Congressional hearings on the ratification of the treaty provide some guidance. In the description of the treaty provided by L. M. Lawson, the United States Commissioner of the IBC and a lead negotiator for the treaty described the drought provision as follows:

Any extraordinary drought affecting the water supply of the Colorado River Basin in the United States will occur in the Upper Basin and the affects will first be felt there. The escape clause in Article 10 will be applied whenever such a condition exists in the upper basin that there must be a reduction in that basin's over-all consumptive use in order to make possible the delivery of an average of 75,000,000 in 10-year progressive series at Lee Ferry, in accordance with the provisions of the Colorado River Compact.

The clause would also apply when the effects of such an extraordinary drought are felt in the lower basin, to the extent that uses in that basin must be curtailed.⁶³

From the testimony, it is clear that the treaty negotiations were based on the hydrologic assumption that the natural flow of the Colorado River at the international boundary averaged about 18 million acre-feet per year, enough water to provide 8.5 million acre-feet to the Upper Basin, 7.5 million to the Lower Basin, 1.5 million for Mexico, and about 500,000 acre-feet of surplus.⁶⁴ However, during the committee testimony, Frank Clayton, attorney for the American section of the IBC, made it clear that there is a distinction between a drought and the normal water supply being less than 16 million acre-feet per year:

Senator Murdock; If there is a deficiency to be made up, it must be made up out of the 16,000,000 acre-feet that is in proportion to the United States?

Mr. Clayton; Yes, Sir, that is correct,

Senator Murdock; So we do not want to mislead the people of the United States who are interested in this water by telling them we can give 1,500,000 acre-feet to Mexico and it will not take away from somebody up the river if there is a deficiency.

Mr. Clayton; That is correct, except that if the deficiency is caused by a drought, we are all in the same boat.

This dialogue raises one of the fundamental questions concerning the relationship between the United States and Mexico on the post-2026 river. If the long-term natural flow of the Colorado River is now in the range of 12.5 – 13.5 million acre-feet per year at Lee Ferry and 13.5 -14.5 million acre-feet per year at the international boundary and, because of climate change, this new baseline will continue to slowly decline, what is the United States treaty obligation to Mexico?

⁶³ Treaty Hearings, Part 1, page 167-8. In his testimony for the six-state coalition that supported the treaty (five basin states plus Texas), Royce Tipton, who was an engineering consultant to the IBC took full ownership of the extraordinary drought provision. Tipton testified that because almost all of the basin's water came from the Upper Basin (and because under the 1928 BCP act, only main stem water and Gila return flows are to be delivered to Mexico) the only real trigger for the extraordinary drought was when the Upper Basin had to curtail uses to make the 75 million every ten years, see Part 3 pages 1082-3.

⁶⁴ HD 419, Appendix I

Even absent climate change, just based on the Natural Flow Data Base, it is difficult to determine when and what portion of a deficiency is caused by “extraordinary” drought. The average natural flow at Lee Ferry from 1931-2017 is 13.98 million acre-feet per year. The five-year period of 2000-2004 averaged only 9.46 million acre-feet per year. Statistically, 2000-2004 was probably an extraordinary drought. However, during that time, while nervous, the Upper Basin never came close to delivering less than 75 million acre-feet in any ten year period and not only were there no curtailments of Lower Basin uses below its compact apportionment of 8.5 million acre-feet , total uses in the basin averaged over 10.5 million acre-feet per year, 24% more than its compact apportionment!

Since 2004, Lake Mead storage has continued to decline, approaching in recent years the elevation 1075’ storage trigger for a first-tier shortage. However, the 2005-2017 average natural flow at Lee Ferry was 13.87 million acre-feet per year, only 0.8% below the long-term 1931-2017 average.⁶⁵ The continuing decline in Lake Mead storage since 2005 despite average hydrology points out the fundamental issue common to a resolution of both Article III(c) of the 1922 compact and Article 10 of the 1944 treaty - the overuse of water in the Lower Basin.

Until recently, the consumptive of over 8.5 million acre-feet of Colorado River water was not a problem for either the Upper Basin or Mexico because this overuse neither increased the cost nor decreased the water available to any user. Now, and presumably for the post-2026 river, the Upper Basin is being asked to potentially deliver more water at Lee Ferry than required by the 1922 compact, which will both increase the cost of implementing a demand management program and decrease the water supply available to existing and future water users. For Mexico,

⁶⁵ March 2019 natural flow data base. If we consider the most recent tree-ring based reconstruction of flows at Lee Ferry going back to 1416, the 2005-2017 period is only 3% less than the average natural flow of 14.3 million acre-feet per year. By any standard, it’s still near average.

it means taking reduced deliveries in years when there may be no drought at all, and thus, subsidizing continued overuse in the Lower Basin.

If the negotiations for the post-2026 river management guidelines are going to be successful, the use by the Lower Basin of more than its 1922 compact apportionment of 8.5 million acre-feet per year must be on the table. This may seem like a very heavy lift, but at one time, the California 4.4 plan, the California QSA, the 2001 Interim Surplus Guidelines, the 2007 Interim Guidelines, and the 2019 drought contingency plans were all considered heavy lifts. Further, by putting it on the table, it does not necessarily mean draconian cuts in the Lower Basin. Instead it opens the door for “grand bargain” solutions that could be win-win-win-wins, (wins for the Upper Basin, Lower Basin, Mexico, and the river environment).

The Case for a Grand Bargain Type Solution

The basic question facing the basin is this: Are the conditions in place that will facilitate what has been labeled a “grand bargain” solution? By grand bargain what we are referring to is a long-term sustainable solution to the basin’s problems providing additional flexibility and security for water uses in the basin, including recreation and environmental flows, while recognizing that there is less water in the system than what was contemplated when the Law of the River was conceived. Such an agreement would be based on the Mulroy principle that the compact can be interpreted broadly by the states and federal government.⁶⁶ The Upper Basin’s

⁶⁶ Patricia Mulroy, now retired, was the long-term General Manager of the Southern Nevada Water Authority. Her statement was that the 1922 compact can mean just about anything the parties to the compact agree it means. See Fleck, John. “What Seven States Can Agree to Do: Deal-Making on the Colorado River.” Stanford University Rural West Initiative.

contested obligation to Mexico under Article III(c), the Lower Basin's overuse of its Article III(a) and (b) apportionments, and the undefined extraordinary drought provision under Article 10 of the treaty with Mexico together with the flexibility of 60 million acre-feet of system storage and system-wide advancements in cooperative conservation solutions may provide a unique opportunity for such a bargain.

Each of the major entities also has something major to lose and is at serious risk without a bargain. For the Upper Basin, its fixed obligation at Lee Ferry will subject it to a diminished supply under the likely impacts of climate change. The likelihood that it will ever use more than its current use of 4-4.5 million acre-feet per year is remote.⁶⁷ To consume much more water, it will require either a new program to put large subsidies into additional irrigated agriculture, big new transmountain diversion, or both.⁶⁸ The current usage trends are flat or declining. New uses like Denver's Moffat expansion or Utah's Lake Powell Pipeline will be more than offset by the retirement of existing coal-fired thermal power plants and since much of the urban growth within the basin is relatively non-consumptive and much of it is occurring on presently irrigated ground, in-basin growth is either neutral or a net-negative. Finally, if the future water supply is at or below what we've seen since the late 1980s, the Upper Basin may have reached peak water. Any new uses will simply require existing uses to be bought up to maintain critical storage levels under a demand management program.⁶⁹ The reality that demand management is really a program to transfer uses is why it will be politically difficult and divisive to implement.

⁶⁷ If we change from using modified Blaney-Criddle, estimates of the Upper Basin's depletions (and the NFDB) will change.

⁶⁸ The possible exception is that climate change could increase the consumptive use by existing irrigated agriculture, but that is offset by urbanization of existing croplands and limited water availability.

⁶⁹ This is the clear message from the Risk Study, phases 1, 2, & 3 sponsored by the Colorado River Water Conservation District, the Southwestern Water Conservation District, the four West Slope Roundtables, and (in part) the Colorado Water Conservation Board.

Going into the negotiations of the post-2026 river, the Upper Basin's traditional opportunities are limited. It could choose to force a resolution of its Article III(c) obligations to Mexico by initiating interstate litigation, but that would be risky. First, there is no better than a 50-50 chance it would prevail. Second, even if it did prevail, the victory could be temporary. The Upper Basin's gains could be negated by the impacts of climate change (or internal development). Third, because of the complex technical issues involved, a supreme court case would be very expensive and would likely take several decades for resolution. During that time, new cooperative projects would be at risk, and it's probable that federal approvals required for any new projects would be on hold. Fourth, the likely winner may be the power of the secretary of the Interior. The river could be "federalized" even more than it is today. Finally, it's not clear that all four States of the Upper Division would stay united through such an endeavor. The likely initiator of legal action would be Colorado as an effort to preserve the dream of a big new transmountain diversion. Whereas, Utah and New Mexico have always been much more pragmatic about the Upper Basin's 750,000 acre-feet per year obligation to Mexico and may not be willing to engage in a long, expensive, and possibly futile fight to help preserve Colorado's dream.⁷⁰

The Upper Basin's alternative is to continue to "muddle along." The Upper Division States would again accept an average obligation to Mexico of 750,000 acre-feet per year and not seriously challenge the Lower Basin's overuse (what we've referred to as the "default" option) under the assumption that any new agreement (operating guidelines) would again be temporary

⁷⁰ Utah and New Mexico have traditionally used what is referred to as the Hydrologic Determination as the technical basis for the quantification of their available water supply from the Colorado River. The Hydrologic Determination is technically a finding by the secretary of the Interior that water is (reasonably) available from Navajo Reservoir under the 1922 and 1948 compacts for contracting to users in New Mexico. One of the assumptions used by the secretary in preparing the 1988 and 2007 versions of the Hydrologic Determination was that releases from Glen Canyon Dam are normally 8.23 million acre-feet per year.

and come with the well-worn legal disclaimer language. The strategy going into the renegotiations of the 2007 Interim Guidelines would be to tweak the tier levels in Lake Powell and Lake Mead, adjust the equalization levels, and make the Lower basin DCP as permanent as possible (a permanent reduction in the structural deficit). An advantage to this approach is that it continues the positive momentum the basin has made with the 2007 Interim Guidelines and the DCPs. A second advantage to this approach is that the Upper Basin would be preserving, at least on paper, its right to develop additional water.

If the future average natural flow at Lee Ferry remains similar to what it has been since the late 1980s, the States of the Upper Division would occasionally rely on their DCP and hope that the individual states will be ready to implement a demand management program, when necessary. If the future average natural flow at Lee Ferry is higher, then the Upper Basin is probably in good shape. However, if the future average natural flow at Lee Ferry declines to levels that we've seen since 2000 or less, then the Upper Basin would be in a position that it would either have to significantly reduce its current consumptive uses or face a serious threat of a curtailment.⁷¹

Under the muddle along strategy, the Upper Basin is at the mercy of future hydrology. Therefore, the possibility of a future curtailment to meet its 1922 compact obligations would remain a major threat. This curtailment threat would likely cause the basin's larger municipal and industrial water providers to "armor" their water rights portfolios by acquiring agricultural rights that are, in theory senior, and thus, unimpaired by the 1922 compact.⁷²

⁷¹ At this level of flows, there would be little doubt that the Upper Basin's obligation to Mexico is 750,000 acre-feet per year.

⁷² Under Article VIII of the 1922 compact, water rights that had been perfected by use prior to the approval of the compact are unimpaired by the compact. In Western Colorado, most agricultural rights were perfected prior to the compact (1922). While the Upper Basin water officials commonly assume that these pre-compact rights would not be subject to curtailment, that assumption and many other details would likely be challenged by the Lower Basin in what would be very messy litigation.

The Lower Basin is also at risk due to its consumptive use of more than the 8.5 million acre-feet per year apportioned to it under Articles III(a) and (b) of the 1922 compact. The Lower Basin's actual use is probably a matter of considerable dispute. However, when both evaporation off Lakes Mead, Mojave, and Havasu and the other human-caused system losses and tributary consumptive uses are added to the uses by Hoover Dam contractors, there is little doubt that total consumptive use exceeds 8.5 million acre-feet per year.⁷³ While there is no 1922 compact penalty for using more water than the prescribed apportionments, it undermines the intent of the compact negotiators⁷⁴ and it creates potential legal and political roadblocks to both using the extraordinary drought provision of the treaty with Mexico and requiring the Upper Basin to meet its obligations under Articles III(c) and (d) of the compact.

The Lower Basin's overuse highlights one of the major unresolved problems in the basin - the lack of a Lower Basin compact among the three States of the Lower Division plus New Mexico and Utah, which have Lower Basin interests in the upper Gila and Virgin River drainages. Because of the Lower basin's overuse, getting to a Lower Basin compact which apportions 8.5 million acre-feet and includes reservoir evaporation and tributary use may now be an impossible task for the reason that it takes too much water away from three States of the Lower Division (Nevada, California, and especially Arizona). For example, assuming Arizona's main stem use is 2.5 million acre-feet per year (300,000 less than its 2.8 million acre-feet of apportionment), its tributary uses are 85% of what they were from 2000-2004, 1.836 million acre-feet, and it share (2.8/7.5) of reservoir evaporation and channel losses (1 million acre-feet

⁷³ Even assuming that the use of Lake mead water is only 7 million acre-feet per year, adding 2 million acre-feet per year of tributary use (under the diversions-less-return-flows accounting method) and 900,000 acre-feet per year of reservoir evaporation and system losses, the total use is still close to 10 million acre-feet per year.

⁷⁴ The purposes of the compact are listed in (the rarely quoted) Article I. Among the purposes listed are: "to provide for the equitable division and apportionment of the use of the waters of the Colorado River System" and "to promote interstate comity."

per year – reflecting a low storage level in Lake Mead) is 373,000 acre-feet per year, the total is over 4.7 million acre-feet per year.⁷⁵ Assuming that Arizona could convince the other states with Lower Basin interests that it was entitled to all 1 million acre-feet of the III(b) water less a small amount for New Mexico and Utah (maybe 150,000 acre-feet), the maximum amount of apportioned water it might get under a Lower Basin Compact would be 3.65 million acre-feet (2.8 million acre-feet of III(a) water plus 850,000 acre-feet of III(b) water). Thus, Arizona would either have to reduce its annual water use by about a million acre-feet or convince the other Lower Basin compact parties to accept its stream depletion theory of accounting. It's difficult to imagine that California would ever agree to Arizona's theory of apportionment accounting (unless it got something major in return such as a major piece of the III(b) water). Even if California did agree, why would New Mexico and Utah further compromise their Upper Basin interests by agreeing to a Lower Basin stream depletion theory?

The States of the Lower Division's path of least internal resistance may be to extend the current package of the 2007 Interim Guidelines, both basin DCPs, and Minute 323 for as long as possible into the future. Why not? Under this package, they can avoid dealing with the messy overuse problems, except for what they've already committed under the DCPs. There is no need to re-open old wounds and take on the tributary and reservoir evaporation accounting problems. Under Minute 323 and the Upper Basin DCP, the Lower Basin's structural overuse is effectively subsidized. There is no diminishment of the Upper Basin's Article III(c) and (d) obligation at Lee Ferry. There is very little real threat that the depletions in the Upper Basin will be increasing

⁷⁵ Making the same calculation for California, since its share of 1,000,000 acre-feet of evaporation is 587,000 acre-feet per year, it would have to reduce its uses from 4.4 million acre-feet per year to 3,813,000 acre-feet per year. Nevada would have to make up for both its tributary use of about 100,000 acre-feet per year and 40,000 acre-feet of evaporation. Assuming Nevada is currently consuming about 250,000 acre-feet per year of main stem water, it's total use would be about 390,000 acre-feet per year. Thus, it would have to reduce its uses (on its tributaries or main stem) by 90,000 acre-feet per year. Although Nevada has made huge progress on conservation in recent years, a further reduction of this amount of water would be challenging.

significantly in the next several decades. And because the States of the Upper Division are prone to overstating their future uses (probably a genetic flaw), the current tiering system favors annual releases of 9 million acre-feet per year as Lake Mead approaches 1075'. The only major disadvantage to this approach may be California's internal problems with finding a real solution to the problems with the Salton Sea.

The Republic of Mexico is also at risk. Under the treaty's Article 10 "extraordinary drought" provision, the United States, which controls all the major system storage reservoirs, has the final say in what is delivered. During the Senate ratification of the treaty, the U. S. negotiators referred to this provision as the "escape clause," implying the U. S. has the final say on when to cut deliveries to Mexico. Mexico does have some leverage because it provides most of the water to the Lower Rio Grande. Further, traditionally, the U. S. State Department has moved very cautiously on treaty matters. Mexico is the position to be either the beneficiary of or the victim of what first happens in the United States as the basins move toward negotiating the post-2026 river. Its best approach may be to hold its cards close and hope that the basins can agree on a long-term solution that works on a smaller (12-13 million acre-feet per year) river. Then, as it did with Minute 323, it would participate in a manner that benefits users in both Mexico and the United States.

Sample "Grand Bargain" Solutions

In the past, suggesting river management approaches that strayed too far from the literal language of the 1922 compact and the other major provisions of the law of the river would have been considered heretical and immediately dismissed by the basin's state agencies and major

water providers. The dry hydrology and overdevelopment seen in the basin since 2000 appears to have changed that dynamic. In 2005 representatives from Colorado first proposed an approach that would cap Upper Basin consumptive uses in return for a relaxation of Article III(d), the 75 million acre-feet every ten years non-depletion provision.⁷⁶ The 2012 Colorado River Supply and Demand Study suggested a number of new and novel approaches to meeting the future water needs of the basin, including water banking. These proposals together with the Mulroy principle (the 1922 compact is flexible) suggest an opening may exist for management options that in the past would have been forbidden ideas.

For discussion purposes, we've identified two possible grand bargain type solutions. The first, referred to as the "Updated Albuquerque" solution, is roughly based on what Colorado suggested in 2005 at a basin states meeting in Albuquerque, New Mexico. It is designed to challenge the limits of the Mulroy Principle. The second, referred to as the "Article III(c) Compromise" is a more traditional solution and generally within the bounds of the Law of the River.

The Updated Albuquerque solution would include the following principles:

1. The Upper Basin would agree to recognize and not challenge the Lower Basin's existing tributary use and total consumptive uses, including reservoir evaporation, in excess of 8.5 million acre-feet per year. For all practical purposes, the 1922 compact Article III(a) and (b) apportionments would be moot.
2. The Lower Basin would agree to never force a curtailment of then existing uses in the Upper Basin to meet any flow obligations at Lee Ferry under articles III(c) and (d).

⁷⁶ See "Risk Management Strategies for the Upper Colorado River Basin" Eric Kuhn, Colorado River Water Conservation District, 2012

3. Lake Mead, Lake Powell, and possibly Flaming Gorge Reservoir would be operated in a coordinated manner to minimize shortages to existing uses in the Lower Basin and Mexico and to maintain critical river ecosystems between the outlet of Flaming Gorge Dam and the inlet to Lake Mead. (Power generation and on-reservoir recreation would also have to be considerations.)

4. The Upper Basin would agree to cap exports from the basin to a negotiated level. (This is based on the compact proposed by Delph Carpenter during the 7th meeting of the Colorado River Compact Commission in January 1922. Carpenter suggested that because of the topography of the Upper Basin, in-basin uses would be self-limiting and therefore not a threat to the Lower Basin. Carpenter acknowledged that transmountain diversions were 100% consumptive, and therefore the Upper Basin would accept a limit on exports.⁷⁷)

5. Both the capacities of Lake Mead and Lake Powell would be available for temporarily storing water made available in the Lower Basin and Mexico through extraordinary conservation. Shortages to the Lower Basin and Mexico would be shared on a negotiated equitable basis and during critical years there would be no limitations on annual uses by the individual States of the Lower Division. For example, if during a future drought in California, MWD needed to operate its aqueduct at full capacity because of supply limitations on the State Water project, California would not be constrained by the 4.4 million acre-feet limit.

6. Under this proposal, Mexico would be considered another Lower Basin user with a normal allocation of 1.5 million acre-feet per year, but subject to the

⁷⁷ See the Minutes and Record of the Colorado River Commission, 7th Meeting pages 105-127. Carpenter expresses his willingness to accept a limit on exports on page 124. *Science Be Dammed*, Chapter 3.

negotiated shortages contemplated in paragraph #5 above. Mexico would have access to storage in Lakes Mead and Powell for managing extraordinary conservation. Under the direction of the Department of the Interior, the three States of the Lower Division and Mexico would be free to establish a secondary market for extraordinary conservation water.

The Article III(c) Compromise solution would include the following principles:

1. The Upper Basin and Lower Basin would agree that the Upper Basin's long term-obligation to Mexico would average 375,000 acre-feet per year (in perpetuity?).
2. The Upper Basin's combined obligations under Articles III(c) and (d) at Lee Ferry would be to not deplete the flow below 78.75 million acre-feet every consecutive ten years. The States of the Upper division would agree that the Upper Colorado River Commission would implement a curtailment pursuant to Article IV of the 1948 compact, as necessary, to not deplete 10-year flows below 78.75 million acre-feet.
3. The Lower Basin would agree that existing water rights perfected by use in the Upper Basin prior to June 25, 1929 would be protected by Article VIII of the 1922 Compact and would not be subject to curtailment to meet the flow obligations under paragraph #2 above.
4. The Upper Basin would agree to recognize and not challenge the Lower Basin's existing tributary use and total consumptive uses, including reservoir evaporation, in excess of 8.5 million acre-feet per year.

5. Mexico would accept a long-term reduction of 75,000 acre-feet per year ($.375/7.5 \times 1,500,000$) for an annual delivery of 1,425,000 acre-feet per year. The logic is that under the compromise, both U. S. basins have, in theory, accepted a reduction in their main stem supplies. Mexico should accept a similar proportional reduction. Mexico would further agree to accept further shortages in years when the Upper Basin must curtail its uses to meet its obligations under paragraph #2 above in the same proportion as total uses are curtailed in the U. S. (the intent here is to provide a working definition of extraordinary drought).

6. The basin states and the secretary of the Interior would agree that for the post 2026 operational guidelines, the “minimum objective release” from Glen Canyon Dam would be the amount necessary to provide an annual flow at the Lee Ferry compact point (practically this is the sum of the Lee’s Ferry and Paria River gauges) of 7.875 million acre-feet per year. This is the number that would be used to set the new tiers and equalization table.

Discussion of the Two Alternative Grand Bargain solutions

The two alternatives are designed to be bookends. The Updated Albuquerque solution is a major change from the current status quo. It caps the Upper Basin’s depletions at a level below its 7.5 million acre-feet per year of apportionment.

The States of the Upper Division benefit because it removes any threat of a future compact curtailment (a “compact call”). It means that the Upper Basin would not have to implement a complicated, costly, and politically divisive demand management program. The Upper Basin’s large municipal and industrial users with post-compact rights would have a

greater certainty of supply (it does not reduce the problems associated with a local drought). Similarly, it provides some relief to the Upper Basin against the impact of climate change. It reduces the downstream delivery obligations. But it does not change the risks of local water supply interruptions.

The primary disadvantage of this solution in the Upper Basin is political. There remains in all four States of the Upper Division a culture of “entitlement.” “The compact promised us 7.5 million acre-feet per year,” the entitlement culture argument goes, “and we’re never going to give it up.” A related disadvantage is that might be seen as benefiting Colorado, which is currently consuming about 56-58% of the total use in the four Upper Division states (more than its 51.75% apportionment) to the detriment of the other three states.

The States of the Lower Division benefit because it removes the difficult problems associated with how to deal with their collective overuse of their 1922 compact apportionments and the unresolved issue of how to attribute Lower Basin reservoir evaporation and channel losses among the states. By gaining access (and primary control) to the capacities of Lake Powell and Flaming Gorge Reservoir, they can further benefit through a coordinated operations plan designed to address and reduce their risks (and meet the river environmental needs).

The primary disadvantage for the States of the Lower Division is that they would be giving up the certainty of supply they now have if climate change continues to diminish the natural flows of the river at Lee Ferry. An agreement by the Upper Basin to cap its uses and not challenge the Lower Basin’s overuse may be seen by many in the Lower Basin as an attempt by the Upper Basin to give up the sleeves on its vest. A further disadvantage is that within the Lower Division, the advantages to this proposal are not equal among the three states. Arizona is the principal beneficiary of the Upper Basin agreeing to not challenge the Lower Basin’s tributary

use and total consumptive uses. In contrast, California is only a beneficiary of the reservoir evaporation provision.

The basin-wide benefits of the Updated Albuquerque solution are that it solves (or moots) the long-standing legal disputes that have remained unresolved. By doing so, it advances comity within the basin and significantly reduces the chances of interstate litigation.

An additional advantage is that the coordinated operations of the three largest reservoirs in the system provides more flexibility to maintain critical environmental values.

A basin-wide disadvantage of the Updated Albuquerque solution is that it would leave the basin's native communities, which have unperfected reserve rights, with no options or resources to develop and use their rights.

The Article III(c) Compromise solution is much more modest and rather than stretch the Law of the River, it is centered around compromise solutions for the contested issues under Article III(c) and Article 10 of the treaty with Mexico.

The major advantages of the Compromise solution for the Upper Basin are that it reduces and settles forever the Upper Basin's obligation to Mexico under Article III(c) and it does so in a manner that, on paper, does not restrict the Upper Basin's future development.

The principle disadvantages are that the Upper Basin still bears the lion's share of the climate change risk, it does not remove the risk of a future compact curtailment, and although the program costs may be less, it would still be under great pressure to implement a demand management program.

The major advantages of the Compromise solution for the Lower Basin are that in return for a compromise reduction of its Article III(c) obligation, the Upper Basin would agree to not

challenge the Lower Basin's overuse of water under the 1922 compact and (under our sample anyway) Mexico would agree to a small reduction in its normal year treaty deliveries.

The major disadvantage of the Compromise solution for the Lower Basin is that by reducing the annual releases from Glen Canyon Dam, it increases the structural deficit (in some years)⁷⁸ from about 1.2 million acre-feet per year to about 1.6 million acre-feet per year. This means that the Lower Basin's current DCP would have to be revised to increase the level of conservation as the storage in Lake Mead approaches elevation 1025'.

The major basin-wide advantages of the Compromise solution are that compared with the Updated Albuquerque solution, it's simpler and therefore, easier to sell back home and implement, and that it reduces the likelihood of inter-state litigation.

The primary disadvantage is that if climate change continues the slow decline of natural flows at Lee Ferry, it may not be an effective long-term solution.

The Importance of Process

To be clear, we are not wedded to the specific details discussed in our examples of what a "Grand Bargain" might look like. As we explain in *Science be Dammed*, "The process by which such a grand bargain might happen may be every bit as important as the technical details of what it would entail."

The key here is to recognize that the problem the Colorado River Basin faces goes beyond a simple recognition that water is over-allocated, and uses need to be reduced. We must

⁷⁸ During drier periods reducing releases from Glen Canyon Dam will accelerate the drawdown of Lake Mead. However, it will also increase the frequency of equalization releases during wetter periods.

pursue that process in full recognition that the over-allocation became embedded in basin rules in very specific ways that remain unresolved today, and it is those specifics that must be fixed.

DRAFT